

AZAD MEMORIAL LECTURES, 1967

SCIENCE AND WORLD PEACE

Instituted in 1958 by the Indian Council for Cultural Relations as a mark of honour to the memory of Maulana Abul Kalam Azad, scholar, statesman and founder-President of the Council, the Azad Memorial Lectures are intended to contribute to the promotion of better understanding among different peoples of the World. Eminent scholars from India and abroad are invited every year to speak on subjects of fundamental importance to humanity at large and in particular to the people of India.

SCIENCE AND WORLD PEACE

LINUS PAULING



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INTRODUCTION

by

M. C. CHAGLA, PRESIDENT, ICCR

Dr. Pauling, Ladies and Gentlemen :

These Azad Memorial Lectures were instituted in 1958 to honour the memory of late Maulana Abul Kalam Azad, a very great son of India and many distinguished people have lectured under the auspices of the Indian Council for Cultural Relations in this series of lectures. I may mention that the very first lecture was delivered by the late Prime Minister Jawaharlal Nehru and the subject was "India Today and Tomorrow". Then we had Prof. Arnold Toynbee, we had Lord Attlee, we had Prof. Raman, also a Nobel Laureate, we had Prof. Hallsstein and Dr. Romulo, and the last of all was the Director-General of UNESCO, Rene Maheu. So you will see that we had rather a distinguished roll of honour. May I say that today we have the privilege to have with us Dr. Linus Pauling who is as distinguished, if not more, as any who has so far come to this Council and participated in these lectures. It is very rare for a scientist not only to get a Nobel prize for Chemistry but also to get Nobel prize for peace. Scientists usually think that

their business lies with science. They are not concerned with the results of the scientific experiments. They think it is not their concern as to what political consequences follow from the researches they do. Scientists are in the habit of living in an ivory tower, not interested in the world around them. I am glad that Dr. Pauling does not belong to that school of thought. He does not live in an ivory tower. He is deeply interested in the world, what is happening in the world and what are going to be the consequences of science. In my opinion, science is a double-edged weapon. One side of the weapon can give to this world the technology it needs, and provide the breakthrough to make the poor countries prosperous. Science has tremendous potentialities in this direction, but science has also the other side which produced Hiroshima and which can destroy this world. The nightmare of Hiroshima still haunts us and it is for science and the scientists to decide where the emphasis should really lie—in its destructive aspect or constructive aspect.

Today we are living in two worlds and not in one world. Disraeli once said that England has two nations, the poor and the rich. Today we can apply that aphorism to the present state of affairs and state that we are living in two worlds—the affluent world and the poor world. The world of affluence where people have more than enough to eat and the world where people often live on the

brink of starvation, and peace will never be achieved unless you bring about a situation when you have one world and not two worlds. It has been said, and rightly said, that we are going through a revolution of rising expectations. People who have recently become free have expectations and they should have expectations. When they look to other countries, they say to themselves why is it that in our country there is so much poverty, ignorance and unemployment, when other countries have superfluity of wealth and amenities of life. This causes friction, frustration, conflicts, even revolutions and therefore, in my opinion, the main task of science today is to build a bridge between the two worlds and when that bridge is built and disparity disappears, we will be near the cause of peace. There is no one today who has more worked for the cause of peace than our distinguished guest and that is why the subject of his lecture is “Science and Peace”. I am sure he is going to tell us how science can be harnessed in the cause of peace. It gives me great pleasure to request our distinguished guest to deliver the lecture.

1 SCIENCE AND WORLD PEACE

Mr. Chagla and Ladies and Gentlemen :

I first express my appreciation of the honor of having been invited to give the Azad Memorial Lectures.

I shall talk today and tomorrow about science in relation to world peace, science in relation to other aspects of the world, especially those aspects of the world that contribute to the happiness of human beings or that lead to misery.

The Nature of Science

Science is the search for knowledge about the world, the search for understanding. It is closely related to philosophy. Bertrand Russell has pointed out that the various provinces of *science*, of knowledge, border on a circumambient area of the unknown, and that the speculative exploration of this area of the unknown constitutes philosophy. When speculation is replaced by knowledge about a certain area of the world, then that area becomes a part of science, and philosophy moves on to other matters.

During past centuries many areas have shifted from philosophy to science. Two days ago President Radhakrishnan told my wife and me that the Upanishads asked many questions about the nature

of the world. What is matter? What is life? What is mind? What is spirit? To the first of these questions, What is matter?, we now know a considerable part of the answer, and this answer, even to the extent that we now know it, has been full of surprises, surpassing the greatest feats of imagination of the earlier philosophers. The quantum theory, discovered in 1900, had not been foreshadowed by the imagination of any philosopher. The uncertainty principle of quantum mechanics, formulated by Werner Heisenberg in 1926, was new and unexpected. The discovery, made about twelve years ago, that the neutrino has the properties of a right-handed propeller was a great surprise. It is astonishing that one of the most elementary and simple constituents of the universe should have the properties of a propeller, so astonishing an idea that when Wolfgang Pauli, who had invented the neutrino, attempted to formulate a mathematical theory of it, thirty years ago, and ran across some simple equations that described it as a propeller, he rejected them and moved on instead to a more complicated set of equations. The experimental evidence in support of the concept of the neutrino as a propeller is now overwhelming. In fact, there are two neutrinos, which are called the electron neutrino and the muon neutrino, and they are both right-handed propellers. No one as yet has had imagination powerful enough to suggest a reason-

able explanation for the existence of these two neutrinos. I am sure that the physicists will continue to present us with surprises about the nature of the world, as they continue their study of it.

As to the second question, What is life?, and the third question, What is mind?, a part of the answers seems to be at hand. Here, too, the answers are surprising. Who would have thought thirty-five years ago that we would now know, in the year 1967, the nature of the gene, that it would be possible to describe in considerable detail the process by means of which the gene duplicates itself, in order that our characters may be passed on to our descendants? During the process of production of a fertilized ovum half of the set of genes of the father and half of the set of genes of the mother, selected by a process that involves randomness, are passed on to the child. Every child is a reincarnation, not a complete reincarnation of any one individual but a reincarnation of many people who preceded him in life and have passed some of their molecules of deoxyribonucleic acid on to him.

Science is the wholehearted search for the truth. It requires a willingness to accept the facts, to reject bias, and dogma. Bertrand Russell said: "There are indeed two attitudes that might be adopted towards the unknown. One is to accept the pronouncements of people who say that they know, on the basis of books, mysteries, and other sources

of inspiration. The other way is to go out and look for oneself; and this is the way of science and philosophy.” Professor P. W. Bridgman of Harvard University said two decades ago : “Science demands that I want to know what the facts are and then to apply my mental tools to these facts.”

I believe that the time has come when the methods of science can and should be applied to all of the great world problems. Modern methods of communication now bind us all together into a single unit, the whole of humankind. The problems of the world have become so great that we must use all of our wisdom in attacking them.

I believe that the scientist has a special responsibility, the responsibility of helping his fellow citizens to understand the great problems, of helping in the solution of these problems, all of which are closely connected to science; and, in addition, the responsibility also of helping to awaken the public conscience about these problems.

Man has reached his present state through the process of evolution. The last great step in the evolution of man was the mutational process that doubled the size of the brain, about two million years ago; this mutational process represented the beginning of the human race. It is this change in the brain that has permitted the inheritance of acquired characteristics of a certain sort, the inheritance of knowledge, of learning, through

communication from one human being to another. Thus abilities that have not yet been incorporated into the molecules of deoxyribonucleic acid that constitute the pool of human genetic material are not lost until their rediscovery by members of the following generations, but instead are handed down from person to person, from generation to generation. It is man's great powers of thinking, remembering, and communicating that are responsible for the evolution of civilization.

During year after year, decade after decade, century after century the world has been changed by the discoveries made by scientists and by their precursors, the brilliant, original, imaginative men and women of prehistoric times and of more recent times who learned how to control fire, to cook food, to grow crops, to domesticate animals, to build wheeled vehicles, steam engines, electric generators and nuclear fission power plants. The discoveries that scientists have made provide now the possibility of abolishing starvation and malnutrition, and of improving the well-being and enriching the lives of all the world's people.

The greatest of the changes made in the world by the discoveries of scientists has been in the matter of weapons and war. I remind you that Alfred Nobel, who was a chemical engineer and inventor, who invented the blasting cap and dynamite and made high explosives safely useable for the construc-

tion of great engineering structures, wanted to invent a substance or a machine with such terrible powers of mass destruction that war would thereby be made impossible forever. Two-thirds of a century later, scientists discovered the explosive substances that Nobel wanted to invent : the fissionable substances uranium 235 and plutonium 239, with explosive energy ten million times that of Nobel's nitroglycerine, and the fusionable substance lithium deuteride, with explosive energy fifty million times that of nitroglycerine. I believe that as a result of these discoveries there will never be another great world war, a great war in which the terrible weapons of nuclear fission and fusion will be used. I recognize that there is a possibility of a great all-destroying war, as the result of some psychological or technological accident or of some combination of circumstances such that even the wisest of national leaders will not be able to prevent the precipitous rush towards catastrophe. But I am hopeful enough to believe that we can avoid this catastrophe. It is the discoveries of scientists, upon which the construction of the terrible nuclear weapons is based, that force us now to abandon war as a means of settling disputes between nations and to develop a system of world law based upon the principles of morality and justice.

I believe that we are now in a state of metamorphosis between the primitive period of history,

when disputes were settled by resort to force, and the period of maturity of the world, when we shall have accepted morality and justice and law, not just for controlling the relations between individuals or small groups of people, but also for controlling the relations between nations.

The Nature of Nuclear War

Let me ask first: Is it true that a great war fought with nuclear weapons would be a catastrophe to the whole of humanity? I believe that we have to answer "yes", that it *is* true; if the nuclear weapons that exist today were to be used in a great war, then, as was stated a few months ago, in November 1966, by a round-table conference of the former Secretaries-General and Presidents of UNESCO and some recipients of the Nobel Peace Prize, civilization would be destroyed, and perhaps the human race itself would be wiped out.

This statement reflects the present state of our knowledge about the nature of nuclear war: we can say with certainty that if all of the nuclear weapons now in existence were to be used in a great nuclear war civilization would be destroyed; but nobody knows whether the human race would survive or not.

The first modern weapon, the twenty-megaton bomb, was exploded by the United States at Bikini on 1 March 1954. This bomb consisted of three successive stages of explosion, all within a few

millionths of a second. First, there occurred the explosion of the trigger, consisting of about ten pounds of plutonium 239; then, as the second stage, the nuclear fusion of about two hundred pounds of lithium deuteride, and then, as the third stage, the nuclear fission of about one thousand pounds of ordinary uranium metal. The ten pounds of plutonium by itself would constitute a small atomic bomb, such as was exploded over Hiroshima and Nagasaki. The Nagasaki bomb was a plutonium-239 bomb, and the Hiroshima bomb was a uranium-235 bomb. The explosive energy resulting from the nuclear fission of about two pounds of plutonium or uranium is equal to that of twenty thousand tons of TNT. This very small amount of explosive material sufficed to destroy the cities of Hiroshima and Nagasaki, and to cause one hundred thousand or two hundred thousand people to be killed. In the modern three-stage nuclear bomb the plutonium or uranium 235 serves as the trigger, which then sets off the reaction of nuclear fusion of about two hundred pounds of lithium deuteride with the release of explosive energy about five hundred times as great as in the Hiroshima or Nagasaki explosions, and the final fission stage releases an equally great amount of energy. The three-stage twenty-megaton bomb, such as the Bikini bomb, has over one thousand times the explosive energy of the Hiroshima bomb or the Nagasaki bomb.

One such great bomb could destroy completely any city on earth. A twenty-megaton bomb exploded over New York, for example, would kill about ten million people by the blast, fire, and immediate radiation effects. Moreover, an area of about ten thousand square miles, extending in the direction in which the wind is blowing, would be grossly contaminated with radioactive fallout that might kill several million more people.

Great three-stage bombs of this sort have been exploded in nuclear tests by the United States, the Soviet Union, and Great Britain*.

These great three-stage bombs have been manufactured by the thousands by the nuclear powers. Three years ago I attempted, on the basis of the available information, to estimate the amount of nuclear explosive in the world's stockpiles. Government officials have stated that the United States has about fifteen hundred great bombing planes. One of these bombers crashed in Spain a year ago. It was carrying four twenty-megaton bombs, each weighing twenty-eight hundred pounds. This single bombing plane was carrying enough bombs to destroy four great cities. The fifteen hundred bombers could carry six thousand twenty-megaton bombs, a total of 120,000 megatons of explosive.

Some years ago, in January 1960, President John F. Kennedy, then a United States Senator,

*Also, since the lectures were given, by the Chinese Peoples' Republic.

made a statement about the magnitude of the world's nuclear stockpiles. His estimate at that time was thirty thousand megatons. One year later the scientists of the Sixth Pugwash Conference estimated sixty thousand megatons, the doubling during the year indicating the continued manufacture of nuclear bombs. My estimate in December 1963 was that the stockpile of the United States amounted to 240,000 megatons and that of the Soviet Union to 80,000 megatons, a total of 320,000 megatons.

The significance of these figures may be made clear by the following statement. The Second World War was six-megaton war; it was carried out over a period of six years, with high explosives used at the rate of about one megaton (one million tons) per year. It would now be easy to compress a six-megaton war into a single day. Let us assume that tomorrow there would take place a small nuclear war, in one day, equal to the whole of the Second World War, and the following day another war equal to the Second World War, and the following day still another, and so on, day after day, for 53,000 days, which is 146 years; then the stockpile of nuclear weapons would be used up.

A great amount of effort has been made to predict the probable effects of a war fought with nuclear weapons. One of the most important publications on this subject was issued by the Atomic Energy Commission of India some six or seven years

ago. Dr. Hugh Everett III and Dr. George E. Pugh of the Weapons Systems Evaluation Division of the Institute of Defense Analyses, in Washington, D. C., made an analysis of the effects of the radioactive fallout alone in causing death. They presented their estimates of the results of attacks on the United States with varying amounts of nuclear explosives. One of their assumed amounts is 10,000 megatons. Ten thousand megatons is an interesting figure because it is the value that gives the same predicted number of deaths whether you aim bombs at the people or not. For less than a ten-thousand-megaton attack you would kill more people by aiming the bombs at the people, that is, by exploding the bombs in various areas in amounts proportional to the population density. For more than ten thousand megatons there are more deaths estimated to be caused by not aiming at the people, but instead distributing the bombs uniformly over the country. The reason is easy to see. In an attack on the United States with the bombs distributed proportional to the population, and with a total of ten thousand megatons, about 500 megatons of bombs would be exploded over New York. Twenty megatons, more than three times the amount of explosives used in the whole of the Second World War, would be enough to kill nearly everybody in New York, so that about 480 megatons of bombs would be wasted.

An attack with ten thousand megatons would kill nearly everybody in the United States. According to the analysis of Drs. Everett and Pugh, sixty days after the attack one hundred ninety million of the two hundred million people would be dead, most of them killed on the first day, eight million would be seriously injured, and two million less seriously injured, but suffering from the effects of radioactivity, and having to cope with the problem of complete destruction of all cities and metropolitan areas and of the means of communication and transportation, death of all livestock, and gross radioactive contamination of all growing foods. An attack with twenty thousand megatons would be needed to produce the same result for the Soviet Union—a larger amount of explosives would be required because of the larger area of the country. These quantities, ten thousand megatons and twenty thousand megatons, are small compared with the stockpiles: ten thousand megatons is one-eighth of my estimate of the Soviet stockpile and twenty thousand megatons is one-twelfth of my estimate of the American stockpile.

If some of the weapons were to be directed towards other countries of the world, as is likely, then similar devastation would be caused there; and if all of the stockpiled weapons were to be used, then great damage would be done over the entire earth by the radioactive materials liberated in the atmosphere.

Even in countries where no nuclear weapons were exploded most of the people would have their lives cut short by cancer produced by the radioactivity in the air, drinking water, and food, and the pool of human germ plasm would be damaged in such a way that the number of normal children might be too small to permit continuation of the human race.

It is hard to understand why the stockpiles of nuclear weapons have become so irrationally great. It is hard to understand how the leaders of nations could have made the decisions to manufacture stockpiles of weapons large enough to destroy civilization. I read in a New Delhi newspaper the other day a statement by United States Secretary of Defense MacNamara that half of the people in the cities of China could be killed by a small nuclear attack, in which fifty nuclear bombs would be exploded over fifty Chinese cities. Secretary Mac-Namara said that fifty million people would be killed in the attack. Such an attack would use only two-tenths of one per cent of the American stockpile of nuclear weapons. The explosive energy of this small fraction of the United States stockpile of nuclear weapons would, however, be eighty times as great as that of all of the explosives used in the whole of the Second World War. The attack could be carried out by use of a small fraction of the available vehicles for delivering nuclear bombs : fifty bombers or fifty rockets.

Last year there was published in the *New York Times* a statement that the Soviet Union now has four hundred intercontinental ballistic missiles and submarine-based ballistic missiles, and the United States has one thousand five hundred. Even these vehicles for carrying the weapons would be enough to insure destruction of the world, without use of the thousands of great bombers and tens of thousands of smaller vehicles, fighters and fighter-bombers, that are able to carry nuclear weapons.

I believe that no one should be ignorant of these figures. From time to time I read that some member of the United States Congress has become impatient with our government for not making use or planning to make use of nuclear weapons in the war in Vietnam. But I would ask: Does the man who has become impatient know the facts that I have presented here? Does he know that the use of nuclear weapons by one country would have considerable probability of leading to the use of nuclear weapons by another country, and then of rapid increase in the magnitude of the war until the final cataclysm would take place a few hours later? Does he know this? And if he does, how can he be so irresponsible as to make the suggestion that nuclear weapons be used? There is still great need for education of the people of the world, including those in positions of responsibility, about the nature of nuclear war and the nature of nuclear weapons.

Among scientists and scholars there is general agreement that a great nuclear war must be prevented and that ultimately we must develop a new world order based upon the principles of justice. The main disagreements that exist are about the lengths of time during which the use of power, the conduct of small wars, and the use of the threat of war should continue, and about the goals that should be achieved in the new world. The only way to prevent the destruction of civilization is to abolish war. No longer can disputes between great powers be settled by a test of military might.

We have already seen some examples of the inhibiting effect of the nuclear stockpiles on the prosecution of war to a conclusion based upon superiority of force. The Korean war, involving the United States, did not end in victory for the country with the greatest military might, the United States. It simply came to an end, an inconclusive end, because it was too dangerous to continue. Even small wars are dangerous, because they may lead to a great nuclear war that would destroy civilization.

The Suez attack is another example. One of the three countries attacking Egypt was a nuclear power. Great Britain had nuclear weapons such as would, if used, have brought the war to an end with victory for the attackers, but it was too dangerous a war to be allowed to continue. The Cuba crisis, too, was not settled by resort to military might,

although there were some threats of use of force. A country with only a small amount of military might, Cuba itself, with a government distasteful to the government of the United States, in a sense emerged the victor. Cuba has not been invaded, despite the dislike of many of the American authorities for the Castro regime.

The Vietnam war is another example. The United States could win this war by killing all of the Vietnam people by use of her nuclear weapons, and there could be no retaliation from Vietnam to a nuclear attack, but this would be too dangerous a way of settling the dispute, because of the possibility of involvement of the Soviet Union in a nuclear war. The Vietnam war, like the Korean war, and the Suez war, is going to come to an end through compromise, not through victory by the country with the greatest military might.

But national selfishness and individual selfishness remain in the world. The powerful people who benefit from economic exploitation do not want to sacrifice any of their profits. They continue to strive, as in the war in Vietnam, to use the methods of power politics and military might, even though this course leads to a tremendous amount of human suffering.

The Need for World Peace

We need to move toward the world of the future, a world based upon world law. Some steps have

already been taken in this direction. The first treaty of the nuclear age was made in 1960, the Antarctic Treaty, stating that Antarctica is to remain free of nuclear weapons. Then there came the Partial Bomb Test Treaty of 1963, which stopped nuclear testing (except underground) by the United States and the Soviet Union and more than one hundred other nations who are signatories.

The bomb tests carried out in the atmosphere during the period 1954 to 1963 amounted all together to six hundred megatons, one hundred times as much energy as was used in fighting the whole of the Second World War. These tests released radioactive materials into the atmosphere, the fission products such as strontium 90, cesium 187, and iodine 131, and also the radioactive form of carbon, carbon 14, which is produced from the nitrogen of the atmosphere by reaction with the neutrons released in both fission and fusion. These radioactive materials damage the tissues of human beings in such a way as to cause them to die of leukemia, bone cancer, and other diseases, and they also damage the molecules of deoxyribonucleic acid that constitute the pool of human germ plasm in such a way as to cause some of the children born in the future to have gross physical or mental defects, so great as to result in death of the child or to lead to serious mental or physical defects throughout the life of the person. Three years ago I estimated that the six hundred

megatons of bomb tests will result ultimately, if the human race survives and is not wiped out in a nuclear war, in a total of sixteen million grossly defective children, who would otherwise have been healthy; and will result also in the death by leukemia, bone cancer, and other diseases of approximately the same number of people, sixteen million.

The Partial Bomb Test Treaty might have been made in 1959 or 1960, but the nations involved were unwilling to reach a compromise about the matter of inspection of underground tests. At that time only one hundred fifty megatons of bombs had been exploded in the atmosphere. The pledges about refraining from testing came to an end. The Soviet Union had pledged that she would not carry out any additional bomb tests so long as no Western nation carried out these tests, and this pledge no longer held after France began her series of weapons tests. The United States' pledge by President Eisenhower expired in January 1960. In 1961 the Soviet Union and then the United States resumed testing. Between 1961 and 1963 four hundred fifty megatons of nuclear weapons were exploded in the atmosphere, quadrupling the amount of contamination of the earth. This additional testing involved the sacrifice of twelve million children, caused to be seriously defective by the radioactive substances, in addition to the estimated four million of the testing up to 1960.

If the Chinese People's Republic and France proceed to test larger nuclear weapons in the same way as the United States and the Soviet Union, another six hundred megatons of bombs will be exploded, further contaminating the atmosphere, and with the consequence that another sixteen million unborn children would be doomed to death or a life of misery, and that roughly the same number of people would be caused to die of cancer.

The damage to human beings and to the human race by these radioactive materials released in the bombs exploded in the atmosphere is an important reason for us to work for a treaty to ban all testing of nuclear weapons, and for a treaty to prevent the spread of nuclear weapons to nations that do not now possess them. Another reason for making these treaties is that the world in which we live is a dangerous place, and will become still more dangerous if these treaties are not made.

I estimate, as do many other scientists, that the probability of outbreak of a nuclear war is approximately proportional to the numbers of pairs of nations possessing nuclear weapons. If there are ten nations with nuclear stockpiles, the number of pairs of interacting nations is $\frac{1}{2}$ of 10×9 , which is 45, whereas with three nations with stockpiles the number of interacting pairs is only 3. This simple argument leads to the conclusion that the world would be fifteen times as dangerous a place if there

were ten nuclear powers as with only three nuclear powers. This is, I believe, a very powerful reason for us to work to achieve a treaty to prevent the spread of stockpiles of nuclear weapons to more and more nations.

Of course, none of these treaties can become effective so long as the Chinese People's Republic is kept out of the world community of nations. In order to prevent the destruction of civilization, the whole world community must join together in the United Nations.

In 1961 my wife and I arranged a conference of physical, biological, and social scientists, in Oslo, to discuss the question of the possible spread of nuclear weapons. The sixty participants in this conference (from fifteen countries) formulated a statement giving the following as the reasons that the spread of nuclear weapons would constitute a grave risk to the world :

1. Each addition to the number of nations armed with nuclear weapons drives its neighbours toward acquiring similar arms.
2. As nuclear weapons pass into more hands, the chance increases that a major war will be started by some human error or technical accident.
3. The spread to more nations increases the chance of deliberate initiation of nuclear war.
4. Increase in the number of nuclear powers would further increase the difficulty of achieving disarmament.

5. After it obtains nuclear weapons, a nation becomes a more likely target in any nuclear war.

There are other deleterious consequences of the acquisition of nuclear weapons by additional countries, either by transfer or development. The manufacture of nuclear weapons requires secret scientific research, which is against the tradition of science, interferes with personal freedom and international cooperation, and inhibits the use of science for the welfare of mankind. Weapons of total destruction concentrate great and often decisive political influence in military, industrial, and managerial groups. Moreover, the means of delivery used by nuclear weapons are such as to make it practically impossible to exercise complete political control over their use.

As an example of the forces that are operating, I may say that I have read in the Indian newspapers an argument to the effect that if there is a danger that Pakistan would obtain nuclear weapons, then India needs a stockpile of these weapons. Also, the argument that China has exploded some atomic bombs and that, to protect herself, India should develop nuclear weapons has been advanced.

As an exponent of morality and peace, I cannot refrain from expressing my disappointment in the action of India in 1962, when the military expenditures of the country were increased from 2·1% of the national income to 4·7%. I hope that India

will again, before long, become the leader of the world in morality and sanity. There is no possibility of India's becoming a world leader in militarism.

I must express my opposition to the proposal that India develop nuclear weapons. I have read that India is now manufacturing weapons grade plutonium, at Trombay, and, according to a statement made by Dr. Homi J. Bhabha, could fabricate an atomic bomb within twelve months. I cannot think of a greater act of folly than for India to follow such a course. Even the United States, the richest nation in the world, is sacrificing the health and well-being of her people to her unfortunate decision to follow a course of militarism, which is now costing 75,000 million dollars per year (30,000 million dollars per year for the Vietnam war alone). This sum, 75,000 million dollars per year is equal to 560,000 million rupees per year, twice the annual income of the whole of India, wasted on militarism.

I hope that the government and people of India will reject the recommendations of persons such as Mr. M. Ramamurti, of the General Electro-Research Institute, who wrote : "Why should not India get a stockpile of nuclear weapons? As the second largest country in the world this would transform her flabby image and give teeth to her power status. The second most populous nation in the world cannot afford to take a back seat just because the late Prime Minister made a commit-

ment that India will not go in for the manufacture of nuclear weapons."

In my lecture tomorrow I shall discuss my ideas about how India can transform her "flabby image", to use Mr. Ramamurti's phrase—and not by wasting money on militarism and atomic bombs.

I must say now that the resurgence of militarism in India cannot be blamed entirely on the Indian government and people. The United States is also in part responsible. Last week a columnist, Mr. T.V. Parasuraman, mentioned in his column in the Indian papers the feeling that but for the United States gift of 1500 million dollars worth of sophisticated military equipment to Pakistan, Pakistan would long ago have reconciled herself to living within her borders.

Last year I was shocked to read that Mr. Henry Kuss, Jr., Assistant Secretary of Defense in the United States, had received the United States Department of Defense Meritorious Civilian Service Medal for his imaginative leadership in the military export sales program. He was given this medal because he had succeeded in selling to the developing countries of the world 1500 million dollars worth of sophisticated weapons, jet bombers, tanks, machine guns, and other equipment, in one year. In his speech of acceptance he said that "With the proper amount of energy, imagination, and vigour, we should by 1971 be selling 15,000 million

dollars worth of sophisticated military equipment to the developing countries." Last week the United States Senate Foreign Relations Committee expressed its concern about the sale of sophisticated weapons to countries of the world that cannot really afford them, with mention of the sale of American Phantom jet fighters to Jordan, Hawker Hunter Jets to Chile, and so on. The principal countries involved in this are the United States, the Soviet Union, France, Great Britain, West Germany, Czechoslovakia, and Sweden. I believe that it is immoral for the rich and highly developed nations of the world to give and sell these weapons of destruction to other nations. I believe that we need to make a treaty among the great powers and other nations to forbid the giving or selling of sophisticated weapons to the underdeveloped nations of the world.

As a citizen of the United States, I am, of course, a revolutionary : I subscribe to the Declaration of Independence. I believe that the people have a right to overthrow an oppressive and dictatorial government. In recent years there have been the beginnings of revolution against oppressive and dictatorial governments in 40 countries, but in many countries there has been the violent suppression of the revolutionary movements. I do not think that it is right to destroy all the hope of a people who are suffering from the oppression of a dictatorship. The development of modern weapons has,

however, made it harder and harder for a popular uprising to be successful. I think that, as a part of a system of world law that is being developed, there must be included a method for a people to rid themselves of an oppressive and dictatorial government, without resorting to force and violence. In the Nobel Peace Prize Lecture that I gave in Oslo on 11 December 1963 I proposed a method by which this might be achieved, without at the same time permitting the possibility of the domination of the small nations by the large nations. This method is to include in the system of world legislation a scheme under which there would be held, perhaps once a decade, a referendum in every country in the world, and supervised by the United Nations, to determine the will of the people with respect to their national government. This referendum in each country might take place in two stages : first, a vote as to whether or not the people desired a special election to be held, permitting them to choose between the government in power and an alternative set of candidates for office; and then, if the special election is desired by the people, a later election, also under international supervision, to permit the people to make the choice between the old government and the proposed new government.

We are, I believe, now in the period of transition between the past, when disputes between nations have been settled by war, and the future, when war

will be abolished and all disputes will be settled by application of the principles of world law. The present time is a very dangerous one, because stockpiles of nuclear weapons exist that could destroy our civilization, if they were to be used. Even small wars are dangerous, because a small war may grow into a great and devastating nuclear war. I believe that it is essential to prevent a great nuclear war, and that this requires the abolition of all wars and the control of nuclear weapons.

There is a special hazard associated with the destruction of the stockpiles of nuclear weapons. The great nuclear stockpiles now act as a deterrent to a nuclear war, because the tremendous destruction that would result from their use makes it clear that nuclear war would be the height of folly. If the stockpiles of nuclear weapons were to be destroyed in large part, the remaining weapons might have such decreased power of destruction as to make the prospect of war attractive to militarists. Moreover, there is the possibility, mentioned by Philip Noel Baker in his Nobel Lecture in 1959, that some nuclear weapons might be concealed or surreptitiously fabricated, and then used to terrorize and dominate the disarmed world. These considerations have led me to suggest an action that might be taken at once to decrease the present great danger of outbreak of nuclear war through some technological or psychological accident or as the result of a series of

events such that even the wisest national leaders could not avert the catastrophe. My proposal is that there be instituted a system of joint national and international control of the stockpiles of nuclear weapons, such that use could be made of the American nuclear armaments only with the approval of the American government and the approval of the United Nations, and that use could be made of the Soviet nuclear armaments only with the approval of the Soviet government and the approval of the United Nations. A similar system of dual control would of course be instituted for other nuclear powers, if they did not decide to destroy their nuclear weapons. I do not know any safer way or better way for us to get through the transition period from militarism to permanent peace than this one, but I believe that the problem is one that needs further discussion, of the sort that scientists have been giving to various problems of science and world affairs in the Pugwash Conferences.

Scientists have the general social responsibility common to all citizens, and also some special responsibilities, resulting from their special knowledge and understanding of science and its relation to the problems of society. I believe that scientists have an important part to play in achieving the goal of the new world, the world of peace and human happiness. It is not the duty of scientists to make the decisions, but rather to help to educate our fellow citizens, to

give them the benefit of our special knowledge and understanding, and then to join with them in the democratic process. We cannot succeed in reaching the goal of the new world, a world without war, unless we accept the principles of justice and morality in relation not only to the disputes between nations that might, in the old days, have been settled by resort to war, but also in relation to all other problems, and, in particular, to the problem of the existing great disparity in the standards of living of different peoples. This already enormous disparity has been increasing, rather than decreasing, in recent years, in part because of the use of a large share of the world's wealth, about 150 thousand million dollars per year, for the support of militarism, and in part because of the allocation of an increasing fraction of the world's wealth to the rich, rather than the poor. Pope Paul VI in his Encyclical letter on the Development of Peoples, said that the poor nations remain ever poor, while the rich nations become richer and richer. I believe that the time has now come in the history of the world for war to be abolished and to be replaced by a system of world law based upon justice, that the time has now come for the people of the whole world to cooperate in using the resources of the world for the benefit of the whole of mankind. I thank you.

2 THE WORLD OF THE FUTURE

Mr. Chagla, Ladies and Gentlemen :

Yesterday I talked about science and peace. I said that science is the wholehearted search for the truth, that it requires a willingness to accept the facts, to reject bias and dogma. I presented some facts about militarism, about nuclear weapons, about the probable nature of a great nuclear war, if there were to be such a war. On applying my powers of reason to these facts, I concluded that to initiate a great nuclear war would be an act of insanity, and that to preserve civilization, to preserve the human race from annihilation, we must abolish war and replace it by a system of world law based upon the principles of justice and morality.

Over a long period of time individual human beings have for the most part accepted the principles of justice and morality. They have built up a system of law as the practical expression of these principles to the actual problems that arise. It is my experience that human beings in the various countries of the world are closely similar to one another, and that they are for the most part good : they are good people. Our problem is that *nations* have not accepted justice and morality, have not accepted

law. Nations have retained a sort of selfishness, which is called patriotism. I believe that it is necessary now to abolish this national selfishness, and to replace it by loyalty to the whole of mankind.

Science and Morality

It is sometimes said that science has nothing to do with morality, and that scientists should leave politics to the politicians, leave morality to the theologians, and do only what they are told to do. I reject these contentions. Science has become a major factor in international relations and in politics. Also, I believe that science is closely connected to morality. The great religious leaders of the past, of the millennia following the birth of civilization, were the early scientists, the wise men who studied natural phenomena, studied the motion of the heavenly bodies, the growth of crops, the behaviour of human beings, and then through exercise of their powers of reason formulated principles of nature and principles of ethical behaviour for the benefit of their fellowmen. The world is no longer the same as it was then, two thousand, three thousand, five thousand, eight thousand years ago. The various religions no longer control humanity, and their teachings have lost much of their pertinence. Religion has not worked to prevent human suffering; it has often aggravated it. Religion has not accomplished the abolition of war; it has often been the cause of wars.

During the last century the world has been changed greatly by the discoveries made by scientists—the clothes we wear, the food we eat, our means of communication and transportation, and our means of waging war have all been changed. Our understanding of the nature of the world has also been increasing rapidly. The religious leaders and the politicians have been having difficulty in keeping up with the changes and with the increases in our understanding. I believe that we are forced now to apply our powers of reason to the question of the possibility of a set of ethical principles that could be accepted by the whole world. There are many rationalists in the world, many atheists, as well as many Christians, many Buddhists, many followers of other religions; and this divergence of religious and philosophical outlook causes me to ask the following question : Is there a basic principle of ethics that can be accepted by everyone? I believe that there is such a principle, which can be developed on a rational, scientific basis, in the following way : My relation to myself is a subjective one, and my relation to the rest of the world is an objective one. Nevertheless, as I consider the evidence of my senses I am led to believe that I am a man, like other men. I know that if I cut myself with a knife I may cry out with pain. I have the subjective feeling of having been hurt. I see that when some other person cuts himself, he cries out

with pain. I conclude from the observation and from many similar observations that he suffers the hurt of the cut, in the way that I suffer the hurt of a cut.

I know what causes me to suffer, and I hope that other human beings will take such actions as to keep my suffering to a minimum. I cannot in justice deny that it is then my duty to take such actions as to keep the suffering of other human beings to a minimum.

I am led by this argument to formulate a rule, which may be called the Golden Rule. As expressed by Luke, it is : As ye would that others should do unto you, do ye also unto them likewise. As a corollary of this rule, which may be applied to the solution of problems, I suggest the principle of working to keep the amount of human suffering to a minimum. Let us all accept this principle as the basis for our decisions, for the decisions of governments.

The question of whether or not to wage a great nuclear war may be discussed, as a first application of the principle of the minimization of the amount of human suffering. Yesterday I discussed the consequences of a great nuclear war. I cannot believe that any sane person would contend that the amount of human suffering in a peaceful world would be greater than the amount of human suffering caused by a great nuclear war. As a second

example, we may discuss the question of a small nuclear attack, such as described by Mr. MacNamara, the United States Secretary of Defence, an attack with perhaps one-thousandth of the United States nuclear stockpile on 50 cities of China, killing an estimated 50 million people. No doubt some militarists, some evil people would be included in this group, but most of the 50 million dead and the many millions injured would be good, moral people, innocent of any great wrong-doing. The alternative course, that of admitting the Chinese People's Republic to the United Nations, giving China her deserved place in the community of nations, co-operating with her in a world brotherhood of humanity for the solution of world problems, would involve so much less human suffering as, I believe, to require its acceptance rather than the acceptance of the policy of carrying out a small nuclear attack to destroy the nuclear installations in the Chinese People's Republic.

Moreover, even the threat of a nuclear attack, such as was made by Secretary MacNamara, must be characterized as unwise. It will surely increase the feeling of the Chinese leaders and of the Chinese people that their country is in danger of attack by a great nuclear power, and will cause China to increase her effort to build up a stockpile of nuclear weapons. But this action of building up an additional stockpile of nuclear weapons itself increases

the probability of a great nuclear war, and is a threat to the whole of humanity. The possibility that a tremendous amount of human suffering would occur as a result of a nuclear war initiated because of the development of a stockpile of nuclear weapons by the Chinese People's Republic requires that the world adopt the alternative course of action with respect to China, as described above.

The War in Vietnam

The war now going on in Vietnam is an immoral war that involves a tremendous amount of human suffering, with no valid justification. When I think of the thousands of young men from the United States who are being killed in Vietnam, in a small, strange country far from their homeland, I am sad, and when I think of the hundreds of thousands of the Vietnamese people who are being killed and injured while they are, as they believe, attempting to repel the foreign aggressor from far across the sea, I am sad. When I think about the phosphorus bombs that burn people to death, the flame throwers, the weapons that shoot out thousands of razor-sharp pieces of steel, causing death or injury to men, women, and children, the use of chemicals to destroy the rice crop, leading to starvation not of the healthy young men in the army, but rather of the sick people, the infants, the nursing mothers, then I am sad; sad that my own country should be involved in this immorality. I have not been able to discover any

possible way in which the war in Vietnam could benefit humanity to an extent sufficient to justify the amount of human suffering that this war is causing.

What are the facts about Vietnam? Vietnam for a thousand years was under nominal control of China, with a sort of governor-general in residence. The people of Vietnam were largely in charge of the country, despite their colonial status. Then the French took over for eighty years, and the Japanese for five years. During the period of Japanese occupation the people of Vietnam developed a strong feeling of independence. Many Vietnamese believed that when the Japanese would be forced to leave, Vietnam would become an independent country. At the end of the Second World War, however, France decided not to give up her colonies in South-East Asia, and a war for independence took place between the Vietnam Liberation forces and the French-Vietnamese forces.

Then, in 1954, there occurred a great example of the power of international negotiation and arbitration. Representatives of a number of nations meeting in Geneva formulated the Geneva Accord, an agreement on the cessation of hostilities in Vietnam. The Geneva Accord is a detailed document. It describes the regions, where fighting had been going on, that were to be made into demilitarized zones, the principal one at the Seventeenth Parallel between the northern part and the southern part

of the country, also a zone around Hanoi, one around Haiphong, and one around another city. The Accord provided for the transfer of prisoners between the two parts of the country and for the voluntary movement of people from one part of the country to another. It provided that the signatories to the agreement and their successors in their function should be responsible for insuring the provisions of the treaty.

One of the statements in the Geneva Accord is that the demilitarized zone at the Seventeenth Parallel is not to be considered a political boundary dividing the country into two countries. Instead, the two provisional governments, in the northern part and the southern part of Vietnam, were bound by the agreement to carry on preparations for an election, to be held under international auspices in 1956 in order that the people of Vietnam might decide what permanent government they wanted for the country.

The United States did not join in this agreement. Under-Secretary of State Walter B. Smith announced, "My government is not prepared to join in any declaration by the Conference such as is submitted."

Then, in 1956, the Diem Government, the first successor government to the French-Vietnamese forces that had signed the Geneva Accord, repudiated the Accord and refused to allow the 1956 election to be held, even though the Accord explicitly bound

any successor government in the same way as the forces that had signed.

As the Diem Government became more and more oppressive and dictatorial, there developed strong opposition to this government in South Vietnam. This opposition grew into a revolution. Senator Fulbright, a respected member of the Senate of the United States and Chairman of the Committee on Foreign Relations, has said that he is convinced that the fight against the Diem dictatorship began as a true revolt of the people in South Vietnam, and not as a subversive activity of North Vietnam.

We may ask why the United States refused to join in the Geneva Accord, and then supported the Diem Government of South Vietnam in its repudiation of this treaty. I think that the answer is that the decision was in part political and in part economic. In 1954 a spokesman for the State Department of the United States said that the policy of our government is to continue to apply pressure on the Chinese People's Republic by fomenting revolts in South-East Asia; to foment war in South-East Asia would be a way of combating Communism. Also, in 1953 President Eisenhower said that "if Indo-China goes... the tin and tungsten that we so greatly value would cease coming."

The war in Vietnam has been greatly intensified during the past two years, and has involved a larger and larger number of United States soldiers, over

500,000 now. It has been expanded to include the bombing of North Vietnam by United States bombing planes, at a rate that is now equal to the bombing rate during the Second World War, approximately 1,000,000 tons of high explosives per year, concentrated on one small, poor country on the other side of the world from the United States.

The efforts to achieve a cease-fire and a negotiated peace of this tragic conflict have failed. President Lyndon B. Johnson only last week repeated a statement that he has made several times before : "If you will name a day and place, you will find the Government of the United States ready to sit down with any other government to discuss the matter of peace in Vietnam." This is a fine statement, except in one respect: it is misleading, because President Johnson excludes the National Liberation Front of South Vietnam, which is carrying on the fight for freedom against the Ky Government of South Vietnam and the United States. I wrote to President Johnson, asking him whether the United States Government were willing to sit down with the National Liberation Front of South Vietnam to discuss a negotiated peace. In answer, I received a letter from Mr. George W. Ball, Under-Secretary of State, in which he said that he was answering for President Johnson. He said that "The policy of the United States Government in this matter is quite

clear; the United States Government does not recognize the National Liberation Front as having any standing under international law." President Johnson, despite his stated willingness to meet with any government to discuss a cease-fire and a negotiated peace in Vietnam, continues to refuse to discuss these questions with the National Liberation Front of South Vietnam.

Secretary-General U Thant of the United Nations has proposed that, first, the United States stop bombing North Vietnam and stop other acts of aggression against North Vietnam; second, that there be a slow-down of military activities in South Vietnam, in preparation for an effective cease-fire; and, third, that negotiations be initiated, including the National Liberation Front. When this proposal was first made by Secretary-General U Thant, in October 1966, President Johnson immediately rejected it.

This savage, irrational, immoral war continues. Soon another year will have gone by, with another ten thousand young Americans killed, many thousands wounded, hundreds of thousands of Vietnamese men, women, and children killed or wounded by the vicious weapons that are now being used. I hope that this horrible episode in the history of the modern world will soon come to an end, that we shall stop this senseless imposition of suffering on the people of Vietnam and the young

men of the United States, stop this irrational waste of the world's resources.

I am reminded of a statement made to my wife and me by President Radhakrishnan three days ago. He quoted a saying of Thucydides, two thousand years ago, that "Power is like a wicked harlot, seducing men and nations to evil and to their own destruction." The United States is the most powerful nation in the world, and the richest nation in the world. Can it be, as is suggested by Thucydides' statement, that the overwhelming military and economic power of the United States has tempted her to try to obtain mastery of the world through force? Or is there another explanation of the participation of the United States in this war—is there a sound argument that would justify the war in Vietnam?

An argument that purports to be a sound one has been presented: it is that we Americans are fighting in Vietnam, undergoing suffering and imposing suffering on the people of Vietnam, in order to prevent a greater amount of suffering in the future; that we are fighting to keep the people of South Vietnam from the domination of a dictatorial Communist government, the Government of Ho Chi Minh, which would cause them so much suffering in the future that the amount of suffering that is now being undergone and imposed is justified.

Is this argument a sound one? Is it a corollary of the moral principle of striving to minimize the

amount of human suffering in the world? I think that it is not. I believe that we cannot predict the future well enough to justify imposing so much suffering on human beings now in order to prevent a possibly greater amount of suffering in the future.

Let us consider the changes that have taken place in the world during the last thirteen years. When the Geneva Accord was signed, in 1954, there still existed in the United States a strong anti-Communist, anti-Soviet feeling. Since then there has been achieved a state of peaceful coexistence between the United States and the Soviet Union, almost a state of amity. This change in the relations between the United States and the Soviet Union, occurring in a period of a few years, suggests that a similar change could occur also between the United States and the Ho Chi Minh Government of North Vietnam, and that it is not justified to conclude that if the people of Vietnam were to decide to accept the Ho Chi Minh Government for the whole country there would occur a tremendous amount of human suffering, as a result of the oppressive actions of a dictatorial government.

Moreover, the actions of Ho Chi Minh himself do not support the thesis that the amount of suffering that would result from the acceptance of his government for Vietnam would be great enough to justify the prosecution of the war. During the

period of French domination of Vietnam Ho Chi Minh became a great national leader. In 1945 he wrote the Declaration of Independence for Vietnam, beginning with the words "All men are created equal. They are endowed by their Creator with certain inalienable rights. Among these rights are life, liberty, and the pursuit of happiness." These are the opening words also of the United States Declaration of Independence. Ho Chi Minh was an admirer of the United States. As I try to picture what the future of the world would have been if we had not opposed the Geneva Accord, if the 1956 elections in Vietnam had taken place, I reach the following conclusions: First, if the elections had been held, they would have constituted a victory for democracy, and would have strengthened the concept of using elections under international auspices as a method of settling disputes. Second, it is likely that the Ho Chi Minh Government would have been selected by the people of Vietnam for the whole of the country. Third, from what I have read about Ho Chi Minh, I think that there is a good chance that his Government in Vietnam would have been friendly to the United States and other Western countries, and would have played a role in international affairs somewhat similar to that played by the Tito Government of Yugoslavia. Fourth, I think it is likely that there would not have been a tremendous amount of human suffering in Viet-

nam, comparable to the amount that has been caused by the Vietnam war.

There might arise circumstances such that the principle of minimizing the amount of human suffering in the world could be used to support the imposition of suffering on people now living in order to prevent a much greater amount of suffering to people who will live during future decades and centuries. I do not believe that these circumstances exist in Vietnam. Moreover, I think that in the world of today and the world of the future the use of international negotiation and arbitration and the application of world law to the settlement of disputes will always involve a smaller amount of human suffering than the use of military might.

The world needs peace, not militarism. Militarism is the cause of human suffering in two ways : directly, through the savagery of the war itself, and indirectly, through the waste of the resources of the world, and the consequent increase in suffering caused by poverty and disease.

Economic Problems

The world needs India as a leader in the fight for peace and world cooperation and in the fight against poverty and disease. There is great misery caused by the abject poverty of about one half of the world's people, yet most of the scientists and technologists of the world are working today to make the rich richer and the poor poorer or are working

on the development and fabrication of terrible instruments of mass destruction death. Even in the United States, the richest country in the world, the poor people are becoming poorer.

During recent years the national income of the United States has increased by about six per cent per year. This increase would suggest that the people are getting richer, but in fact the increase has not brought prosperity to the poor people, the ordinary people. First, there has been an increase in population of between one and two per cent per year; second, there has been inflation, decrease in the purchasing power of the dollar, by about two per cent per year; and third, there has been, during the last eight years, an increase in the profits from investments from eight per cent of the invested money per year to fourteen per cent per year, on the average, and also an increase in the amount of invested money greater than the increase in the national income, leading to an increase in the fraction of the national income that is paid to the investors, rich people, and the corresponding decrease in the fraction that goes to the ordinary people, the poor people.

Militarism is the explanation of the inflation, the decrease in the purchasing power of the dollar. There would not have been inflation in the United States except for the great military budget. As to the increase from eight per cent to fourteen per cent in the average profits from investments, this unbridled

economic exploitation that is now operating in the United States will lead to catastrophe if it is continued.

We do not have completely free enterprise in the United States. There are government regulations of various sorts, which are planned to operate to control monopolies and to achieve a proper distribution of the national income among the various classes of people. These regulations, however, have not been operating effectively during the recent years.

When I visited Nehru's house in New Delhi, I saw that he had made the following statement: "I dislike imperialism, I dislike the capitalist system." I agree, in large part. I dislike imperialism, military colonialism, and economic colonialism, the exploitation of the poor people, whether they live in the developed countries or the underdeveloped countries. I dislike the capitalist system when it operates in an unbridled way. I believe in free enterprise, but not so free and unrestrained as to introduce gross inequities. I believe that we should work toward a goal of having in every country in the world a social, political, and economic system that permits the maximum freedom of choice to every person, compatible with the rights of other persons. By allowing the freedom of choice to persons—choice of vocation, choice of place of residence and living conditions, choice as to the division of time between

work and recreation (with in general an accompanying decrease in income associated with a decrease in amount of work done), choice of association with other persons in personal relationships. A system based upon individual freedom permits a great increase in the happiness of human beings with no significant decrease in the happiness of others. I have observed that bureaucracy may operate in such a way as to cause much human suffering with no corresponding benefit to any human beings or to society. An example that has come to my attention recently is the refusal of the government of a country to allow a young woman citizen of the country to marry her fiance, who had emigrated to another country. I believe that freedom of enterprise should not, however, permit a person or a small group of persons to obtain ownership of great natural resources, or ownership of corporations providing public services, which are essentially monopolistic. I believe that the state should carry on many activities, providing services to the people as a whole and preventing the exploitation by monopolistic private corporations that operate in a way that does damage to the people as a whole. It is my opinion that the Socialist governments of the Scandinavian countries provide the best approximation to the ideal at the present time.

In the world of today we see processes operating that can lead to serious economic exploitation and

neo-colonialism in the near future. India should be warned by the example of Chile and other Latin American countries, where a small initial investment of money by foreign capitalists, such as the investment one hundred years to fifty years ago in the nitrate and copper mines of Chile, has led to the continued bleeding out of larger and larger amounts of money from the country. The natural riches of the country itself have largely gone to benefit people in foreign countries. The ideal economic policy at the present time is that of the four Scandinavian countries, Sweden, Norway, Denmark, and Finland. These countries have laws forbidding any foreigner to own any part of industry or any property within the country. Even a citizen who moves outside the country and becomes a permanent resident of some other country must give up his ownership of stock and property in the country. This is a way of preventing the disaster of continued economic exploitation of the resources of the country by foreigners.

An underdeveloped country, such as India, may have such need for capital to permit industrialization that such a policy could not be adopted. For such a country I advocate that the policy be to obtain loans and to permit investments only during a limited period of time. Foreign investors might be allowed by the Government to make their investments and to withdraw the profits from the

investments for a limited period of time, such as twenty years or ten years, with the requirement that the industrial installations revert to Indian ownership, either Government or private, within a certain period of time, ten years or twenty years. Ten years might seem a short period of time, but it should be sufficient. The Government of Puerto Rico has published advertisements, in the effort to attract additional industry from the United States, in which the Government states that the average profit on investments in Puerto Rico made by American Corporations was twenty-eight per cent per year. If a fourteen per cent return on the invested money were to be considered the proper profit (the present average for investments in the United States), and the remainder of the twenty-eight per cent were to be allocated to reducing the amount of the invested money, this average profit of twenty-eight per cent would amortize the original investment within five years. This would constitute a method of preventing the disaster of the continued economic exploitation of the country by foreigners.

The recommendation that I am making is that India should undergo industrialization and further development in such a way that she becomes self-reliant; to permit permanent investment of capital by persons or corporations in foreign countries will lead to exploitation and prevent the increase in prosperity of the country. The policy that I advo-

cate is, I judge, essentially that described in Prime Minister Nehru's statement in Parliament on 6 April 1949 : "Major interest ownership and effective control of an undertaking should be in Indian hands."

I have made an effort to analyse the economy of India, with use mainly of the *India Pocketbook of Economic Information* (Department of Economic Affairs, Ministry of Finance, 1966), as the source of facts. My analysis has led me to the conclusion that during the past eighteen years the people of India have been getting poorer.

The per capita income in India was Rs. 250 average per year in 1948, and Rs. 500 in 1966. The average income, measured in rupees, has accordingly doubled during this period. The purchasing power of the Rupee, however, has decreased: one hundred Rupees in 1966 has the purchasing power, for food and other essential commodities, of only forty-two Rupees in 1948. The average per capita income for 1966, Rs. 500, has the purchasing power equal to that of Rs. 210 in 1948. This amount, Rs. 210, is less than the 1948 average income of Rs. 250, and accordingly, I am led to the conclusion, stated above, that the people of India as a whole have been getting poorer, rather than more prosperous.

In attempting to find the cause of this trend toward poverty and away from prosperity, I may ask first as to the cause of the inflation of the currency.

From one of the tables of the *India Pocketbook of Economic Information* we learn that the Rupee decreased in purchasing power by an average of 3·4 per cent per year during fourteen years from 1948 to 1962. From the tables in this *Pocketbook*, supplemented for the last year by the *Quarterly Bulletin of the Eastern Economist for 1966*, I find that inflation has increased to ten per cent per year during the four years from 1962 to 1966. During the four years since 1962 inflation of the Rupee has caused a decrease in the purchasing power of the people's money by 64,000 million Rupees, an average of 16,000 million Rupees per year.

In the year 1963 the military budget of India was more than doubled, so that it reached the amount 4·7 per cent of the national income, which was 340,000 million Rupees; that is, the military budget reached the amount of 16,000 million Rupees in 1963. This sum of money, the military budget, is just equal to the decrease in the purchasing power of the income of the people of India that has been caused for the average year since 1962 by inflation of the Rupee. This comparison indicates that the purchasing power of the people's income would not have decreased if these great expenditures for militarism had not taken place.

I am not at this point discussing the arguments for and against the decision to increase the military budget for India; I am merely pointing out the

facts about inflation of the Rupee and its magnitude in relation to the military budget.

Another economic fact of great significance and relevance to the problem of the increasing poverty of India is that there has been a continued deficit in the foreign exchange of India. India has, year after year, spent more money for imports than was received for materials exported. Before 1958 India had reserves of gold and silver and of credits in foreign countries. During the years up to 1958 the deficit in the foreign exchange was made up from the accrued reserves, by the shipment of gold and silver to foreign countries and by cancelling the foreign credit. Since 1958, however, the deficit has been made up largely by the issuance by the Government of India of additional paper money.

During the last four years the amounts of the deficit in foreign payments, as given in the *India Pocketbook of Economic Information*, were 3,600 million Rupees in 1962-63, 3,900 million Rupees in 1963-64, 5,100 million Rupees in 1964-65, and 4,500 million Rupees in 1965-66, averaging a little over 4,000 million Rupees per year for these last four years.

The amount of money in circulation in India (in thousands of millions of Rupees) was 18·48 in 1951-52. In ten years, in 1961-62, it had increased to 30·46, an increase averaging five per cent per year, not much greater than the increase in the population (averaging 3·4 per cent per year). During the

next four years the money in circulation increased far more rapidly, to 33·10, 37·52, 40·80, and 45·13 (as given in the *Quarterly Bulletin of the Eastern Economist for 1966*). During these four years there has been an average increase in the amount of money in circulation by 10·3 per cent per year, far greater than the population increase.

During the last four years the amount of additional paper money issued each year has averaged 3,670 million Rupees. By issuing a total of 14,670 million Rupees in additional paper money during the last four years the Government of India has largely made up for the deficit in foreign payments during these four years, amounting to a total of 17,000 million Rupees.

It is this issuance of large amounts of paper money by the Government of India, however, that has been in large part responsible for the great inflation in the value of the Rupee during this period. The index number of prices of all commodities, on the base 100 for 1952-53, had risen to 127·9 by 1962-63, and to 197·5 by January 1967, as reported by the Government on 12 February 1967. The increase amounted to an average of 10·0 per cent for the three years from 1962-63 to 1965-66 (index number 169·9 in January 1966).

The inflation of the Rupee, consequent to the issuance of larger amounts of paper currency, led to the devaluation of the Rupee last year.

That the situation is getting worse rather than better is indicated by the great increase in the price index from January 1966 to January 1967, an increase by 16·2 per cent in one year (from overall index of wholesale prices 169·9 in January 1966 to 197·5 in January 1967). This is the largest increase in the price index that has ever occurred. Economic analysts have reported that the phenomenal increase in price index during the last year was due in part to devaluation and in part to the unparalleled drought in several parts of north India and the consequent decline in agricultural production. The increase in population, which results in an increased demand for food, must also be included among the causes.

The overall index of wholesale prices is less significant as a measure of the state of poverty or well-being of the people than the price index for food. During the year from January 1966 to January 1967 the wholesale price index for rice increased by 19 per cent, that for bajra by 29 per cent, that for pulses by 44 per cent, that for edible oils by 25 per cent, and that for sugar and gur by 42 per cent.

The economic situation of the ordinary people of India, as measured by the purchasing power of their average annual income, remained roughly constant during the period from 1948 to 1961. It then began to get worse. The last year, 1966 to 1967, has seen a catastrophic decrease in the purchasing

power of the average annual income of the people of India. If the situation continues to worsen, it will lead to a horrible catastrophe, probably, in a few years, to the death by starvation, malnutrition, and preventable disease of tens of millions of the Indian people.

THE POPULATION OF INDIA

Earlier in these lectures I mentioned that the national income of the United States does not in itself constitute a measure of the well-being of the people of the country, and that increase in population is one factor that must also be taken into consideration. The population of the United States is now increasing by somewhat less than 1·5 per cent per year, as the result of immigration and of natural increase (excess of birth rate over death rate). The rate of natural increase of population for the United States in a representative recent year, 1963, is given as 1·2 per cent (birth rate 2·12 per cent, death rate 0·94 per cent) by Roger Revelle, Director of the Harvard Center for Population Studies, in his article on population and food supplies, published in the *Proceedings of the National Academy of Sciences of the United States of America* for August, 1966. The average rate of population increase for the countries that might be described as developed countries (large amount of industrialisation, per capita income more than \$ 1000 per year) was 1·2 per cent in 1963,

ranging from 0·3 per cent for Hungary to 1·6 per cent for Canada, and is probably less now. Increase by 1·2 per cent per year leads to a doubling in the population in sixty years. The underdeveloped countries, with a gross national product less than \$ 400 per capita per year, have a rate of natural increase of more than three per cent per year, which leads to a doubling in the population in twenty-four years, a quadrupling in forty-seven years. The problem of increasing production of food and other commodities to provide for such an increased population is a tremendous one, which the underdeveloped countries have not been able to solve. This problem has for many countries become serious only during the last decade or two. One hundred years ago the death rate in many countries was equal to the birth rate, and there was no natural increase in population.

A great change in the conditions of health and the causes of death has taken place in many parts of the world during the twentieth century. In former centuries the principal causes of death were the diseases of childhood that result from a combination of infection and malnutrition. This combination of infection and malnutrition as a cause of death is still the most important in many of the underdeveloped countries, but in the developed countries infant mortality is low, for most developed countries ranging from 0·10 to 0·25 per cent (death

before one year of age), childhood deaths are rare, most people live at least to middle age, and cardiovascular disease and cancer are the principal causes of death. The control of infectious diseases has been largely responsible for this change.

In India the birth rate in 1951 was four per cent per year (forty births per thousand population per year) and the death rate was 2·7 per cent, corresponding to a rate of natural increase of 1·3 per cent per year. The birth rate now is four per cent per year, but the death rate has decreased rapidly, because of control of infectious diseases, and is only about 1·5 per cent per year, leading to a natural increase in the population by 2·5 per cent per year.

Let us consider the effect that the decrease in the death rate has had on India. During the sixteen years between 1951 and 1967 the birth rate has continued essentially unchanged, at four per cent per year. The death rate was 2·7 per cent per year in 1951. It has decreased steadily, and was 1·8 per cent per year in 1961. The rate of natural increase in population had changed from 1·3 per cent per year in 1951 to 2·2 per cent per year in 1961, an extra 0·9 per cent per year.

During the last sixteen years the population of India has increased from 365 million to 500 million. This increase has been to a considerable extent the result of the decrease in the death rate from 2·7 per cent in 1951 to 1·8 per cent in 1961 and

then to 1·5 per cent at present, with no significant decrease in the birth rate, and with corresponding increases in the rate of natural increase in population, from 1·3 per cent in 1951 to 2·2 per cent per year in 1961. Let us ask how many people there would be in India at the present time if the birth rate had decreased from year to year by the same amount as the death rate, so that the rate of natural increase had remained at 1·3 per cent per year.

A rate of natural increase of 1·3 per cent per year leads to an increase in population by twenty-three per cent in sixteen years; that is, the population would have increased from 365 million to 450 million by 1967, rather than to 500 million. There are 50 million more people in India now than there would have been if the birth rate had been decreased by an amount sufficient to make up for the decrease in the death rate.

This extra 50 million people is ten per cent of the present population. Fifty million extra people to be fed constitutes a most serious added economic burden, which is in part responsible for the increasing poverty of the people of India.

A rapid increase in the population does not lead to security, nor to power, nor to wealth. It leads to poverty and to misery.

Methods of controlling the population by preventing conception are now available. The cheapest and most certain are vasectomy and salpingectomy.

The Government of India has adopted an enlightened policy of responsibility for control of the population. In the past, it has not, however, applied this policy in an effective way. It is essential that the birth rate be decreased to correct for the decrease in the death rate, and indeed, even somewhat more, to bring the increase in population to a stop, to achieve the elimination of poverty, to increase the well-being of all the people, to move toward the goal of national prosperity and greatness.

This path should have been taken fifteen years ago, in 1951, when the great decrease in the death rate became definitely known in the census. It is absolutely essential that it be taken now.

Let there be in every family one, two, or three children, but then let every pressure, incentive, and aid be exerted to bring the population increase to a stop.

The Goals for the World

The foregoing consideration of the problem of the increasing population of the countries of the world leads to the formulation of a general question, a sort of philosophical question.

As a citizen of the United States of America, I may first formulate the question in the following way : What is the proper population for the United States of America ?

We have a country two and one-half times India in area, with a population of 200 million. Is 200

million the right number of people to have in the United States? What is the right number?

In the State of California, where my wife and I have lived for forty-five years, after we left the State where we were born, Oregon, there are now nineteen million people. The State of California is equal to Japan in area. In Japan there are ninety-eight million people. One might conclude from this comparison that California is not yet overcrowded and that the proper population for California might be greater than nineteen million.

From my own observations of Japan, however, I conclude that Japan is overpopulated. I believe that the amount of human suffering would be decreased in the future if there were in Japan a somewhat smaller number of people than ninety-eight million.

I also feel that there are now in California as many people as there should be. More and more orange groves and other agricultural regions are being replaced by towns and cities, converted into urban regions. The great redwood forests are being cut down, in order to provide increasing amounts of lumber for the construction of houses and for other uses. The natural wonders of California are being destroyed.

There is no doubt that the population of California will continue to increase. I believe that this increase in population will lead to overcrowding and

to a decrease in happiness of the people of my State.

To answer the question about the proper population of the United States, I apply the basic ethical principle, which I have discussed, the principle of the minimization of human suffering. What number of people living in the United States would permit those individual human beings to lead the best lives, the fullest lives, the richest lives, with the greatest freedom from the human suffering that is caused by poverty and disease, with the greatest satisfaction of their intellectual curiosity, of their cultural needs, of their love of nature?

I believe that 200 million people in the United States is too many. In the middlewestern and eastern parts of the country, most of the water is polluted. The people do not have the happiness that comes from drinking good natural water; instead they drink dilute sewage that has been contaminated by organic and industrial contaminants and subjected to chemical treatment. It tastes and smells of chlorine and other solutes. In many parts of the United States the atmosphere is also contaminated with oxides of nitrogen and sulphur, with hydrocarbons and aldehydes and other hydrocarbon reaction products, and with carbon monoxide and particles of dirt and soot. In many parts of the United States there is increasing sacrifice of the wonders of nature, the wilderness regions, the great forests.

I believe that we should have as the number of people in the world the optimal number, such a number as would lead to the preservation of the beauties and wonders of the world, as would permit the people to enjoy the wonders of nature as well as the wonders of civilization, to lead full and rich lives. I think that the people of the United States should make the decision now to stabilize our population at a number somewhat below 200 million, and that the birth rate should, by decision of the people, be controlled to a value somewhat less than the death rate.

On 31 August 1966 Sir Joseph Hutchinson, Professor of Agriculture in Cambridge University and President of the British Association for the Advancement of Science, gave his Presidential Address to the Association. This address was on the question "What should be the population of the United Kingdom?" He pointed out that the water supply in the United Kingdom is inadequate, that the people of Britain do not have good water to drink, and that there are problems of the disposal of sewage and problems of industrial contamination of water and of the atmosphere that the Government and the people have not been able to handle. The country, with fifty million people, is overcrowded to such an extent that there are not proper opportunities for recreation and enjoyment of full lives for the people of Britain. He said that instead of fifty

million people in the United Kingdom there should be only forty million, and that the Government should adopt the policy of achieving this goal over the next few generations, by the control of population by procedures formulated through thorough and careful discussion of the problem, such as to involve only such interference as is necessary in the private affairs of individual human beings.

And what should be the goal for India? I have pointed out that during recent years the people of India have been becoming poorer and poorer, that the decrease in purchasing power of the money earned by the average person in India has been especially great during the past few years, and that the economic decline, which can be attributed in part to the military expenditures by the Government, is also in large part the consequence of the very rapid increase in population. I think that the people of India may well be less happy than they were five thousand years ago, during the Stone Age. In Kerala a few days ago I watched the fishermen who were diving and fishing from sunrise until sunset, getting only a meager catch, diving into the ocean for mussels all day long in the hope of making enough money to live or getting enough food to keep them alive; I watched the workers beating coir, little boys, men, and women working from early morning until late at night to earn enough money to keep alive, living in huts like those in which men

lived at the dawn of civilization, living lives not greatly different from those of Stone Age man. However, some thousands of years ago the people living in that region had purer water flowing in their rivers and streams. The number of people was not so great as to contaminate their water supply. The food available could be gathered without the extreme competition that exists now. Stone Age man did not have books to read, he could not go to the cinema for recreation. But approximately seventy-two per cent of the people of India now are illiterate; to these seventy-two per cent of the people the intellectual satisfaction of reading is still denied. Many do not have enough money to go to the cinema. The average amount of food eaten by the people of India amounts to 1,940 calories per day. Many people must get much less food than this. I have no doubt that a large fraction of the people of India are undernourished, half-starved.

I suggest that, in order that the people of India may be healthy and happy, may lead lives with greater intellectual and philosophical satisfaction, the Government and people of India should adopt the proposal made by Sir Joseph Hutchinson for the United Kingdom in his British Association address. The suggestion by Sir Joseph Hutchinson that there should be forty million people in the United Kingdom, instead of fifty million, may be translated for India as a proposal that there should

be 400 million people in India rather than 500 million. The effort should be made, over a period of a few generations, to reach this goal of a population of 400 million. It may be that a revision of the goal would be made before even one generation has gone by; perhaps the revision would be in the direction of a still further reduction.

The policy should, I believe, be one that permits every family to have one or two or three children. I believe that one of the greatest sources of human happiness is that of having children, of knowing that of the complement of one hundred thousand molecules of deoxyribonucleic acid that constitutes the genes you yourself have received from your forebears and that have determined your nature, one half, fifty thousand, have combined with fifty thousand molecules of deoxyribonucleic acid contributed by your wife or husband to determine the character and the nature of the new human being who represents a sort of fusion of you and your spouse, a sort of reincarnation of you and your spouse, of your parents and your wife's parents. But then let there be every pressure, every incentive, every aid available to bring the family's increment to the population to a stop. I repeat that this is the path to the elimination of poverty, to the increase in the well-being of all the people, to national prosperity and greatness. It is essential that this path be taken, that this policy be adopted and prosecuted

vigorously by the nation as a whole. It is already late. The burden of the extra fifty million people has already made itself evident in such a way as to suggest the impending catastrophe.

With a smaller number of people India would be able to contribute more actively than now to the solution of the great world problems. We are all brothers, we human beings, we, the men, women, and children of the world, and we must join together in solving the great world problems in preventing catastrophes, in cutting down the amount of human suffering and misery that is due to the maldistribution of the world's wealth and to the ravages of war.

I believe that if we work together we can abolish war, abolish economic exploitation, abolish the misery that results from ignorance, poverty, and disease, and that we shall in the course of time achieve a world full of happy people, a world with economic, political, and social justice for all human beings and with a culture worthy of man's intelligence.